Chapter 2

Theory of Operation

2.1. System Block Diagram

This chapter presents FibeAir 1500 basic principles of operation. The FibeAir 1500 design concept is based on universal radio architecture. A radio link consists of two FibeAir 1500 terminals. Each terminal includes three major LRU's, IDU, ODU and the Antenna. A single cable, carrying communications and DC power, interconnects the IDU with the ODU.

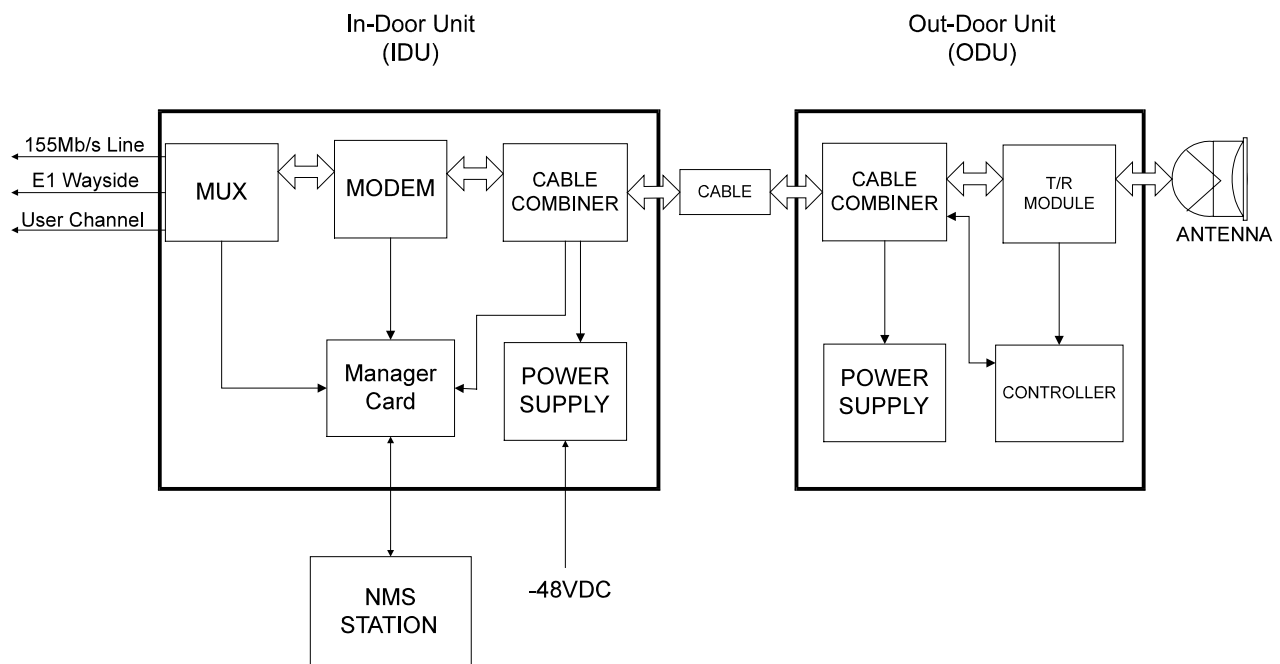Figure 2-1 presents FibeAir 1500 main blocks and modules.

Figure 2-1 FibeAir 1500 System Block Diagram

2.2.   In Door Unit (IDU)

The IDU is a compact, 17" wide, 1U-high unit, mount compatible for both ETSI and ANSI standard racks. The IDU modulates/demodulates the 155Mbps Sonet/SDH payloads, manages local and remote units, provides I/O line alarms, and provides interfaces for 1.544/2.048 Mbps Wayside channel, 64Kbps User channel and 64Kbps Order Wire channel.

The IDU also interfaces a Local Maintenance Terminal or Network Management System. In addition, status alarms and indicators are provided on the front panel.

The IDU major modules:

■   Multiplexer

■   Modem

■   Manager Card

■   Cable Interface

■   Power Supply

2.2.1. Multiplexer

The Mux module functions as a Sonet/SDH Regenerator. On the line side it interfaces the OC-3/STM-1 stream, and on the radio side the Modem module.

As a regenerator, the MUX either terminates or regenerates the OC-3/STM-1 RSOH. In one direction, the OC-3/STM-1 stream, interfacing through the MUX's Rx line input terminates and the resulting stream is transmitted to the Modulator in the Modem module.

In the opposite direction, the stream coming from the Modem's Demodulator, undergoes OC-3/STM-1 Regeneration in the MUX, and transmitted through the MUX's Tx line output.

In addition, the MUX module uses the OC-3/STM-1 SOH bytes to support other services: 1.544/2.048 Mbps Wayside channel and management, 64 Kbps User Channel and Order Wire channel.

The MUX module may be configured via software for transparency of most of the SOH bytes for maximum system transparency and non-intervention, at the cost of reduced functionality and services.

The multiplexer module enables to integrate different interfaces and services into the SDH payload to converge Datacom and Telecom applications.

2.2.2. MODEM

The FibeAir 1500 is equipped with a 16-states QAM Modem. The modem delivers a 155 Mb/s payload in 50/56 MHz channel bandwidth in compliance with FCC/ETSI standards. The Modem is equipped with Digital Signal Processing functions as follows:

■　　Digital IF - I/Q modulator/demodulator whose functions are:

⇒Conversion of the modulated signal to/from the IF frequency.

⇒Automatic level equalization on the signal from ODU.

⇒Protection against overloads.

■　　Timing recovery techniques employing digital tracking loop.

■　　FEC ensures unfaded BER lower than 10^{-13}.

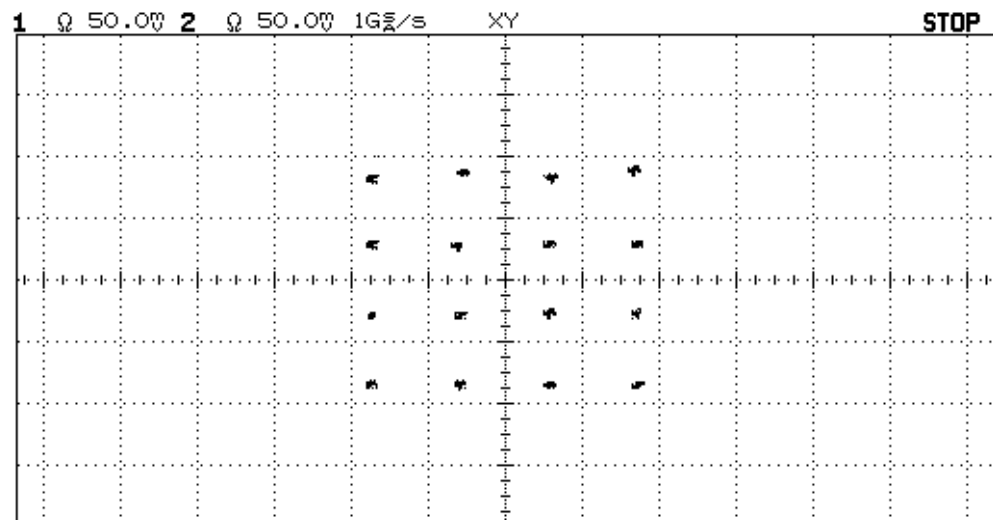The following figure illustrates a measured 16 QAM constellation.

Figure 2-2 16 QAM Constellation

2.2.3. Manager Module

The Manager module controls and manages all system's modules, local and remote units.

The Manager module also supports the user interface through Ethernet or PPP/SLIP to the management station, and an ASCII terminal port. A local or dumb terminal can be used for basic configuration and performance monitoring.

Other features include:

■   Log file.

■   Remote software and firmware download (upgrades can be downloaded from local to remote).

■   Performance monitoring.

2.2.4. Cable Interfaces

A single coaxial cable connects the IDU to the ODU. This cable carries the following signals:

■   Transmit and receive modulated signals.

■   Transmit and receive control data and communications between the IDU manager and the ODU controller.

■   DC power from the IDU to the ODU.

The system automatically issues an alarm if the cable is disconnected and provides protection against shorts. Furthermore, there is no need to measure and define the length and type of cable used since the system automatically compensates cable parameters.

The following figure illustrates the signal direction through the coaxial cable.
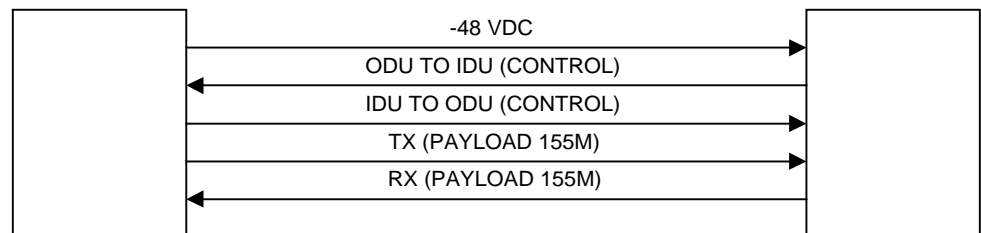

Figure 2-3 Signal Direction Through the Coaxial Cable

2.2.5. Power Supplies

The power supply features:

- Standard Input : -48VDC

- DC input range   : -40.5VDC to -72VDC

- DC/DC converter.

- Reverse polarity protection.

- Over-voltage and over-current protection.

- Detection of IDU-ODU cable alarms (i.e. cable open, cable short).

The ODU receives its DC power from the IDU. The PWR LED on the front panel of the IDU continuously lights to indicate the existence of input voltage.

2.3.   Out Door Unit (ODU)

The ODU is designed to be fastened to the antenna using four latches. The antenna is mounted on a standard mounting pole. The ODU is enclosed in a compact, weather proof enclosure and connects to the IDU via a single coaxial cable that can extend up to 300m (1000 ft).

The ODU major modules:

- T/R Module $-$ A high sensitivity RF circuitry with full band frequency tuning range.

- Controller $-$ Controls the ODU and provides ODU status signals, and accurate received signal level (RSL) reading (in dBm).

- Cable Combiner $-$ Detailed in paragraph 2.2.4.
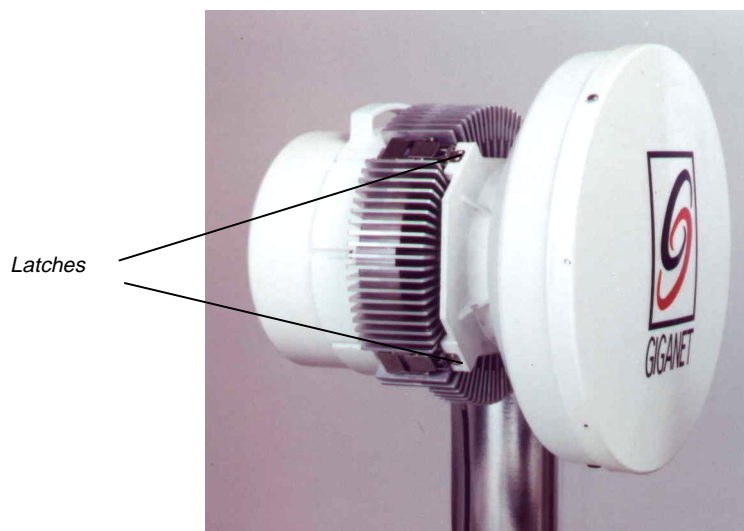
- Power Supply - Detailed in paragraph 2.2.5.

Figure 2-4 ODU Mounted on the Antenna

2.4.   System Specifications

2.4.1. General

	18 GHz	23 GHz	26 GHz	28 GHz	38 GHz
Standards	FCC/ETSI	FCC/ETSI	ETSI	FCC/ETSI/ Canada	FCC/ETSI
Operating frequency range	17.7 - 19.7 GHz	21.2 - 23.6 GHz	24.5 - 26.5 GHz	27.5 - 28.35 GHz / 27.5 - 29.5GHz/ 27.35 - 28.35 GHz	37 - 38.4, 38.6-40 GHz/ 37-39.5 GHz
Tx/Rx spacing	1560/1010 MHz	1200/1008 MHz	1008 MHz	450/1008/500 MHz	700/1260 MHz
RF channel spacing	50/55/80 MHz	50/56 MHz	56 MHz	50/56 MHz	50/56 Mhz
Capacity	OC-3/STM-1 or equivalent				
Modulation type	16 QAM				
Frequency stability	+/- 0.0005%				
Frequency source	Synthesizer				
RF channel selection	Via NMS				
System configurations	Non-Protected (1+0), Protected (1+1)				

2.4.2. Frequency

Frequency	Supported Standards
18 GHz	EN 300 430, CEPT T/R12-03, ITU-R F.595-5, FCC parts 15, 101 (formerly parts 21, 94)
23 GHz	EN 300 198, BAPT 211 ZV 02/23, MPT 1409, CEPT T/R13-02, ITU-R REC. F.637-2, FCC parts 15,101 (formerly parts 21,94)
26 GHz	EN 300 431, BAPT 211 ZV 11/26, MPT 1420, CEPT T/R13-02, ITU-R REC.748-2
28 GHz	EN 300 431, CEPT T/R13-02, ITU-R REC.748, FCC parts 15, 101 (formerly parts 21, 94)
38 GHz	EN 300 197, BAPT 211 ZV 12/38, MPT 1714, CEPT T/R12-01, ITU-R REC.749, FCC parts 15,101 (formerly parts 21,94), FCC: NZ4 GNT-FA-1500-38

2.4.3. Radio

	18 GHz	23 GHz	26 GHz	28 GHz	38 GHz
Transmitted Power	22 dBm	20 dBm	20 dBm	20 dBm	15 dBm
Tx Attenuation Range	30 dB	30 dB	30 dB	30 dB	25 dB
Receiver Sensitivity (BER=10^{-6})	-73 dBm	-72 dBm	-72 dBm	- 72 dBm	-70 dBm
Receiver Overload (BER=10^{-6})	Better than -15 dBm				
Unfaded BER	Better than 10^{-13}				

2.4.4. Antenna

	18 GHz	23 GHz	26 GHz	28 GHz	38 GHz
1 Ft Gain	33.5 dBi	35 dBi	36 dBi	36.6 dBi	39 dBi
2 Ft Gain	38.5 dBi	40 dBi	41 dBi	41.5 dBi	44 dBi
3 Ft Gain	42 dBi	43.5 dBi	44.5 dBi	---------	---------
4/6 Ft Gain	44.5/48 dBi	46/49.5 dBi	47 dBi	---------	---------
Polarization	Vertical or Horizontal				
Standard Mounting OD Pole	51mm $-$ 114mm/2.0"-4.5" (Subject to vendor and antenna size)				
High Performance	ETSI class 2, 3				

2.4.5. Payload

155.52 Mb/s Main Channel

Payload Types	Sonet/SDH: OC-3/sts-3, OC-3c/STS-3c, SDH: OC-3/STM-1, ATM over Sonet/SDH, IP over Sonet/SDH, 3xDS3/ES3, 3xE3
Physical Interfaces	Electrical: CMI, UTP, STP, optical: single-mode, multi-mode, long-haul and short-haul
Compatible Standards	ITU-T G.703, G.707, G.783, G.823, G.957, G.958, ITU-T I.432, ATM Forum, ETSI ETS 300 147, ETS 300 417, ANSI T1.105, ANSI T1.102-1993, Bellcore GR-253-core, TR-NWT-000499

1544/2048 Kb/s Wayside Channel

Available Interfaces	T1/E1, Ethernet bridge 10Base-T, V.35, X21, RS-530 or V.36

64 Kb/s User Channel

Available Interfaces	24 (RS-232, DB9, 64 Kb/s synchronous, 19.2 Kb/s asynchronous), or Ethernet bridge 10Base-T

Service Channel

Engineering Order Wire	ADM CVSD audio channel (64 Kb/s)

Note:
All interfaces for Main and Wayside Channels are available via modular, plug-in interface units.
* 3xDS3/ES3 model is provided with a V.24 (RS232, DB9) user channel

2.4.6. Network Management, Diagnostics, Status and Alarms

Type	SNMP, in compliance with RFC 1213, RFC 1595 (Sonet MIB)
Local or Remote NMS Station	GiganetView^{TM} with advanced GUI for Windows 95/98/NT^{TM} or UNIX^{TM}, integrated with HP OpenView^{TM}
NMS Interface	Ethernet bridge 10Base-T, RS-232 (PPP, SLIP)
Local Configuration and Monitoring	Standard ASCII terminal, serial RS-232
Cascaded Topology	Internal IP routing allows cascaded link topology
TMN	Giganet NMS functions are in accordance with ITU-T recommendations for TMN. Interconnection to TMN is available via Q3 interface upon specific requirement
External Alarms	8 Inputs, TTL-level or contact closure to ground, 5 Outputs, Form C contacts, software configurable
RSL Indication	Accurate power reading (dBm) available at IDU, ODU and NMS
Performance Monitoring	Integral with an on board memory per ITU-TG.826

2.4.7. Environmental

Operating Temperature (Guaranteed Performance)	ODU: -35oC to 55oC IDU: -5oC to 45oC
Relative Humidity	ODU: up to 100% (all weather operation) IDU: up to 95% (non-condensing)
Altitude	Up to 4,500m (15,000 ft)

2.4.8. Power

Standard Input	-48V DC
DC Input range	-40.5 to −72V DC
Optional Input	AC

2.4.9. Mechanical Dimensions

ODU	25 cm diameter x 20/23 cm depth (10" diameter x 8" depth) 8.45 kg weight
IDU	4.3 cm height x 43.2 cm width x 24.0 cm depth (1.7" x 17" x 9.4") 2.7 kg weight
IDU − ODU Coaxial Cable	RG-223 (100 m/300 ft), Belden 9914/RG-8 (300 m/1000 ft) or equivalent, N-type connectors (male)